Verified Statement of Translation

I, Martin Geissler, hereby declare the following:

I am knowledgeable in **German** and English. I have reviewed the English translation of German priority Application No. DE 10346540 filed in German, and believe the attached document to be an accurate translation thereof.

All statements made herein of my own knowledge are true and all statements made on information and belief are believed to be true. Further, these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Charge Air Cooler for a Motor Vehicle

The invention relates to a charge air cooler for a motor vehicle according to the preamble of claim 1.

Charge air coolers for motor vehicles are known; they are used to cool combustion air that has been compressed by a supercharger or a turbocharger in order to better charge the cylinders i.e. to improve volumetric efficiency. Air-cooled charge air coolers are typically used in motor vehicles, such as the type made known e.g. in DE-A 198 57 435 or DE-A 199 62 861, which belongs to the applicant. The charge air cooler typically includes a heat exchanger block or a "network" composed of tubes, typically flat tubes or square tubes, between which corrugated fins are disposed to increase the amount of surface area available for heat transfer. The tubes are held in tube bases via their tube ends. Tubes, fins, and tube bases are composed of aluminum materials and are soldered to each other. "Air chambers", which function as distributors or collection chambers for the charge air, are mounted on the tube bases. These air chambers can likewise be composed of an aluminium material, or they can be composed of plastic. Liquid-cooled air charge coolers are used in certain applications, in which case the coolant in the cooling circuit of the internal combustion engine is used to cool the charge air. The charge air cooler for a motor vehicle is typically fastened in front of or behind the coolant radiator, and is often part of a cooling module that is disposed in the front engine compartment of the motor vehicle.

Due to soot formation in the exhaust gas, particle filters are being used to an increasing extent in diesel engines for passenger cars; these particle filters must be regenerated at certain intervals. In certain types of particle filters, the temperature of the exhaust gas must be increased for the regeneration to occur (to burn off the soot), although this is often not possible to do when external temperatures are low. The invention is based on

the assumption that the exhaust-gas temperature required to burn off soot can be increased by reducing the cooling of the charge air.

The problem addressed by the invention, therefore, is to equip a charge air cooler of the type described initially with means that enable the cooling of charge air to be reduced, as necessary, compared to the standard cooling of charge air.

This problem is solved by the features of claim 1. According to the invention, a certain number of tubes of the charge air cooler are closed to reduce cooling, that is, charge air is prevented from flowing through these tubes. Thus, charge air flows through only 10 percent or 20 percent of the tubes, for example, thereby reducing the cooling of the emerging charge air. The advantage is therefore achieved of increasing the temperature of the exhaust gas, which is necessary in order to regenerate the filter and to burn off soot, even under unfavorable external conditions such as low external temperatures.

According to an advantageous embodiment of the invention, the tubes through which charge air should not flow are closed using a closing mechanism that is preferably disposed in one of the air chambers i.e. on the intake side or on the exhaust side. It is advantageous that the closing mechanism is integrated in the charge air cooler and need not be installed separately.

Closing mechanisms for closing a number of tubes are known in the context of exhaust gas heat exchangers. For example, an exhaust gas heat exchanger for an exhaust gas auxiliary heater was made known in DE-A 199 62 863, which belongs to the applicant, in which case the exhaust gas is directed through the exhaust gas heat exchanger or a bypass using a "switch". This switch is designed as a flexible actuator. Other forms of exhaust flaps or closing mechanisms were made known by DE-A 102 03 003, wherein this exhaust gas heat exchanger likewise includes an integrated bypass having a switch, and the flow of exhaust gas is directed through all tubes of the exhaust gas heat exchanger or through the bypass. Finally, exhaust gas heat exchangers for heating motor vehicles were made known by DE-C 31 03 198 and DE-C 32 18 984, in which case the flow of exhaust gas is directed through different flow ducts using flaps situated

in the heat exchanger. As such, the heating power can be adapted to different flows of exhaust gas.

According to an advantageous embodiment of the invention, the flap is designed as a rectangular flap having a lateral pivot axis that is situated in the direct vicinity of the tube ends and therefore covers or closes a portion of the tube ends. The flap can be situated in the air chamber and fastened therein relatively easily. When the flap is open, that is, when none of the tubes is closed, the placement of the flap against the wall of the charge air chamber does not result in an additional pressure reduction for standard charge air cooling, in which case charge air flows through all tubes.

According to a further advantageous embodiment of the invention, the air chamber is subdivided by a partition into two chambers, a portion of the total number of charge air tubes being assigned to each chamber. Preferably, the two chambers are joined to form one funnel-shaped duct (bottleneck), where the closing mechanism is located. The closing mechanism closes one of the two chambers, preferably the chamber having the greater number of tubes, thereby interrupting the flow of charge air through these tubes. The advantage of this solution is that the closing mechanism can be designed to be smaller than the cross-sectional area of the tubes to be covered, and therefore the actuating forces used to adjust the closing mechanism are likewise reduced. This tapered duct cross section is preferably round, and the flap is fitted to its cross section accordingly.

The problem addressed by the invention is furthermore solved by the features of claim 13 which depicts a parallel solution to claim 1. Flow travels through the charge air cooler in a "U" shape, that is, the flow travels through the charge air cooler twice, and the charge air cooler includes a charge air chamber having an inlet opening and an exhaust opening, and a partition and a return chamber. A closing mechanism, preferably a round swivelling flap, is situated in the partition. The advantage of reduced charge air cooling is likewise achieved when the flap is open since a considerable portion of the inflowing charge air enters the outlet directly i.e. uncooled. The main advantage of this solution is

that the closing mechanism in the partition is relatively easy to implement structurally and therefore only a minimal amount of extra effort is required.

Embodiments of the invention are depicted in the drawing and are described in greater detail in the following.In the figures:

Figures 1, 1a	show a first embodiment of the invention, which includes a swivelling flap,
Figure 2	shows a second embodiment, which includes a round flap,
Figure 3	shows a further embodiment, which includes a round flap and a partition in the air chamber,
Figure 4	shows a modified embodiment, which includes a partition and a recessed flap,
Figure 5	shows a perspective depiction of the embodiment that includes a partition and a recessed flap, and
Figure 6	shows a further embodiment, which includes a flap in a partition.

Figure 1 shows a schematic depiction of an outlet-side air chamber 1 of a charge air cooler which is not depicted in entirety and which includes a further inlet-side air chamber that is not depicted. Air chamber 1, on which an air outlet that is not depicted is situated, is mounted on a tube base 2 and is connected thereto. Tube base 2 is preferably manufactured out of an aluminium material and includes a row of passages which is situated perpendicularly to the plane of the drawing and is not depicted in detail, and into which tubes 3 are inserted via their tube ends 3a, and are soldered. Air chamber 1 can be manufactured out of a plastic or an aluminum material. Thus, the connection to metallic tube base 2 is a mechanical flare-fitting joint or a bonded connection e.g. a solder connection. Tubes 3 have a rectangular cross section, the long side of which extends parallel to the plane of the drawing and has depth T. Corrugated fins, which are not shown, are disposed between tubes 3 and, in conjunction with tubes

3, form a heat exchanger block or a "network" through which ambient air flows in the direction of arrow L. A charge air cooler of this type is situated in the front region of an engine compartment, which is not depicted, of a motor vehicle, typically together with further heat exchangers such as a coolant radiator. A flap 4 that is capable of swivelling is situated in charge air cooler 1, pivot axis 5 of which is located next to tube end 3a and in the region of tube base 2. Flap 4 is shown in the open position i.e. in a position that is approximately parallel to a side wall 1a of air chamber 1. To close tube 3 or individual tubes 3, flap 4 is swiveled by 90 degrees, thereby bringing it to rest on tube end 3a and sealing it shut. The actuation of flap 4 and its support in air chamber 1 are not depicted; they correspond to the related art mentioned initially. The flow through charge air tubes 3 travels in the direction of arrow LL, that is, flap 4 is opened with the flow pressure, and it is closed against the flow pressure. It is likewise possible to situate the flap in the air chamber on the charge air inlet side, although this configuration is not depicted. Arrow LL would then have to point in the opposite direction.

Figure 1a shows an enlarged depiction of flap 1 in relation to tubes 3.1, 3.2, 3.3, 3.N-1 and 3.N which form a row R. Flap axis 5 of flap 4 is likewise situated slightly above the tube ends, and is supported in a manner that is not depicted. Flap 4 is rectangular and has a height H and a width B. Height H corresponds to depth T (see figure 1) of tubes 3, and therefore the tube cross sections are covered when the flap is closed. Width B in figure 1a is selected such that tubes 3.2 through 3.N-1 are covered when flap 4 is closed, and only the two outer tubes 3.1 and 3.N remain open and have charge air flowing through them.

Figure 2 shows a further embodiment of the invention, which includes an outlet-side air chamber 6 which is connected in a plane 6a containing a not-shown tube base or a heat exchanger block to tubes that lead into the tube base. A charge air outlet 6b is located on the side of air chamber 6 facing away from plane 6a. An angled partition 7 is situated inside charge air chamber 6, is composed of three regions 7a, 7b, 7c, and subdivides air chamber 6 into two chambers, namely a first, closable chamber 8 and a second, through-flow chamber 9. A round swivelling flap 10 is situated between partition wall regions 7b, 7c and has a circumference 10a which is depicted in the through-flow

position using a dashed line. The closed position is depicted using solid line 10. A first number of not-shown tubes leads into closable chamber 8, and a second number of not-shown tubes leads into through-flow chamber 9, the second number of tubes being smaller than the first number – as shown in the illustration – that is, by a ratio of approximately 1 : 2 to 1 : 3. When chamber 8 is closed, charge air flows only through the tubes that lead into through-flow chamber 9. Thus, the cooling of the charge air that leaves the charge air cooler through outlet 6b is less than if flap 10 were open and flow traveled through all tubes of the charge air cooler.

Figure 3 shows a modified embodiment of the embodiment, which includes an air chamber 11 that abuts, via a plane 11a, a not-shown heat exchanger block of a not-shown charge air cooler. Air chamber 11 includes an outlet neck 11b and a partition 12 which is indicated using a dashed line and extends from parting plane 11a into outlet neck 11b. Partition 12 subdivides air chamber 11 into a first, larger chamber 13 and a smaller, second chamber 14 which is a through-flow chamber. Chamber 13 is closable in the region of outlet neck 11b by a round swivelling flap 15, circumference 15a of which is indicated using a dashed line. When flap 15 is closed, which corresponds to solid line 15, chamber 13, into which a first number of not-shown tubes lead, is closed i.e. the flow through these tubes is interrupted. In contrast, the not-shown tubes that lead into through-flow chamber 14 are open and have charge air pass through them, thereby cooling the charge air. In all, when flap 15 is closed, the charge air that flows through the charge air cooler is cooled to a lesser extent than when flap 15 is open (standard cooling).

Figure 4 shows a modification of an embodiment according to figure 3, which includes air chamber 11, partition 12, and outlet neck 11b which has a circular cross section that is folded into the plane of the drawing as indicated by dashed line 11c. The cross section of outlet neck 11b is subdivided by a section 12a of partition 12 into two partial cross sections 13a, 14a, wherein partial cross section 13a, which corresponds to chamber 13, is closable by a round swivelling flap 16. Swivelling flap 16 is shown in its closed position in the drawing as a solid line 16, and it is shown in its open position as a dashed line 11c which is cut off by partition wall section 12a, and therefore full circle 11c

(dashed line) is recessed in the region of partial cross section 14a. Partial cross section 14a is therefore always open. A perspective depiction of this embodiment is shown in the next figure.

Figure 5 shows the embodiment according to figure 4 in a perspective depiction, wherein the same reference numerals are used for the same components. Charge air chamber 11 abuts, via plane 11a, a not-shown tube base that accommodates tube ends 17a of square tubes 17. Corrugated fins 18 are situated between rectangular tubes 17 (tubes having an approximately rectangular flow cross section). Air chamber 11 covers the entire tube base, which is not shown in entirety, and is subdivided by transverse partition 12 into chambers 13 and 14. Air chamber 11 tapers in the manner of a funnel to an inlet neck (outlet neck) 11b which has a circular cross section 11c. Circular cross section 11c is subdivided by partition 12 into partial cross section 13a (darkened region) and partial cross section 14a. Round swivelling flap 16 is situated in partial cross section 13a, which may be swivelled about a flap axis 16a or (alternatively) about a pivot axis 16b. In both cases, swivelling flap 16 closes or opens partial cross section 13a, thereby interrupting the flow of charge air through chamber 13 and the tubes connected thereto. The flow through tubes 17, which are shown at the bottom of the drawing, and into which chamber 14 leads, is not interrupted, however. These flow ducts remain open at all times. The control of flap 16 is not depicted; it takes place from the outside e.g. in a manner that is explained in the initially-mentioned related art for exhaust gas heat exchangers.

Figure 6 shows a further embodiment of the invention for a charge air cooler 20 which includes a heat exchanger block 21, an upper air chamber 22 and a lower air chamber 23 which is a "return chamber". Upper air chamber 22 includes an inlet neck 24 and an outlet neck 25, and a partition 26 situated between them, partition 26 subdividing air chamber 22 into an inlet chamber and an outlet chamber 24a, 25a, respectively. Charge air cooler 20 therefore accommodates flow in a "U" shape, that is, in two directions as indicated by arrows P, from top to bottom and from bottom to top. A round swivelling flap 27 is situated in partition 26, outline 27a of which is a dashed line, folds into the plane of the drawing, and indicates the open position. Swivelling flap 27 which is

controllable from the outside in a manner that is not depicted therefore opens or closes a circular cross section 27a in partition 26. When flap 27 is closed, standard charge air cooling takes place i.e. by 100 percent. When flap 27 is open, not all of the charge air flows through block 21 as indicated by arrow P, but rather only a portion thereof. The other partial flow passes directly from inlet neck 24, through the opening in partition 26, to outlet neck 25. The cooling of the charge air is therefore only partial i.e. the charge air that exits outlet neck 25 has a higher charge air temperature than it does when standard cooling is performed.

Claims

1. A charge air cooler for a motor vehicle, comprising a heat exchanger block that includes tubes (3) through which charge air can flow, and comprising air chambers (1) connected to tubes (3), which have a charge air inlet and a charge air outlet,
characterized in that
a portion of the tubes is closable.

2. The charge air cooler according to claim 1,
characterized in that
the portion of the tubes can be closed using a closing mechanism (4, 10, 15, 16).

3. The charge air cooler according to claim 2,
characterized in that
the closing mechanism (4, 10, 15, 16) is situated in the charge air chamber (1, 6, 11).

4. The charge air cooler according to claim 2 or 3,
characterized in that
the closing mechanism (15, 16) is situated in the vicinity of the charge air inlet.

5. The charge air cooler according to claim 2 or 3,
characterized in that
the closing mechanism (10) is situated in the vicinity of the charge air outlet (6b).

6. The charge air cooler according to one of the claims 2 through 5,
characterized in that
the closing mechanism is designed as a swivelling flap (4) having a laterally disposed pivot axis (5).

7. The charge air cooler according to claim 6,
characterized in that
the tubes (3) form a row R and include tube ends (3a) which are accommodated in a

tube base (5) of the air chamber (1), and in that the pivot axis (5) is situated in the direction of tube row R and next to tube ends (3a) in the vicinity of tube base (5).

8. The charge air cooler according to claim 7,
characterized in that
the flap (4) is approximately rectangular and bears against tube ends (3a) in the closed position.

9. The charge air cooler according to one of the claims 2 through 5,
characterized in that
a partition (7, 12) is situated in the air chamber (6, 11), which subdivides the air chamber into two chambers (8, 9; 13, 14) having two flow cross sections (13a, 14a), and in that one flow cross section (13a) can be closed using the closing mechanism (10, 15, 16).

10. The charge air cooler according to claim 9,
characterized in that
the chambers (13, 14) and the partition (12) transition, in the shape of a funnel, into an outlet neck (11b), in which the closing mechanism (15, 16) is situated.

11. The charge air cooler according to claim 10,
characterized in that
the closing mechanism (15) is designed as a round flap having a central pivot axis (15).

12. The charge air cooler according to claim 10,
characterized in that
the closing mechanism is designed as a round, partially recessed flap (16) having a lateral pivot axis (16a) or central pivot axis (16b).

13. A charge air cooler (20) for a motor vehicle, composed of a heat exchanger block (21) having tubes through which charge air can flow, and composed of air chambers (22, 23) that are connected to the tubes and have a charge air inlet (24) and a charge air outlet (25),

characterized in that
a charge air chamber (22) is subdivided by a transverse partition (26) into an inlet chamber (24a) and an outlet chamber (25a), each of which has the charge air inlet (24) and the charge air outlet (25), and in that the other air chamber (23) is designed as a return chamber, and in that a closing mechanism (27) is situated in the transverse partition (26).

14. The charge air cooler according to claim 13,
characterized in that
the closing mechanism is designed as a flap, in particular as a round swivelling flap (27) having a a central pivot axis.

Abstract

The invention relates to a charge air cooler for a motor vehicle, comprising a heat exchanger block that includes tubes (3) through which charge air can flow, and comprising air chambers (1) which are connected to the tubes (3) and include a charge air inlet and a charge air outlet.

It is provided that a portion of the tubes is closable, preferably using a closing mechanism (4) situated in the air chamber (1).